Chapter 3

Aim, Objectives, Hypothesis and phases of the study
3.1 Aim of the study

This study aims to find the effect of considering various biomechanical variables in treating PFPS.

Objectives

1. To find the influence of various biomechanical factors of lower limb on severity of pain in subjects with PFPS.
2. To find the effectiveness of adding bio mechanical corrective approach to conventional physiotherapy management on prognosis of severity of pain and function in subjects with PFPS.
3.2 Null Hypothesis

This study hypothesise that there will not be a significant difference in the prognosis when influential biomechanical factors were considered while framing intervention for patella femoral pain syndrome.
3.3 Phases of the study.

The study was carried out at STUTI department of physiotherapy, Bapunagar, Ahmedabad. Every patient was clearly explained about the procedure that will be done and the role that the subject has to play during the study following which the patients signed an informed consent form. The study was done in two stages. Phase 1 of the study was a cross sectional study, where an analysis of biomechanical factors was done on the severity of pain in Patello femoral pain syndrome. Phase 2 was an interventional study, in this Phase of the study the Bio mechanical aspects which were considered to be the main contributors for the severity of pain was attested along with conventional exercises to find the effectiveness of the same. The same is explained in the Fig 3.1.

**Phase 1**

Cross sectional study to analyse the influence of various biomechanical factors in determining the severity of pain in PFPS

50 Subjects were selected

Data collection, demographic data, history and self reported measure of pain was taken using pain severity scale
In detailed examination we used special tests like step down test, lateral step down test, Q-angle measurement, Navicular drop test, Crag's test, SLR etc.

It is recommended from this phase that any intervention attesting patellofemoral joint pain should consider that navicular position, Q-angle and femoral anteversion these three factors in bringing about a better and faster recovery

Phase 2

Effect of biomechanical approach in management of PFPS

Methodology
Randomized control trial was done

30 subjects were selected

History of knee pain during ascending or descending stairs, jogging or hopping activity

Patients were randomly assigned into two groups, each group has 15 subjects

Group A received conventional exercise in the form of ultrasound therapy to the patellar tendon, taping and strengthening exercises of the hamstrings and quadriceps.

Group B received conventional set of exercises that received by Group A and also Bio mechanical approach and postural correction therapy.
Then outcome measures were used are numerical pain rating scale, mc-gill pain questionnaire, anterior knee pain scale, womac scale.

The confidence interval for this study was maintained at 95% with 3 degrees of freedom.

Fig. 3.1 Flow chart of the study
Phase 1 – Cross sectional study to analyse the influence of various biomechanical factors in determining the severity of pain in PFPS

3.4. Introduction

There is no clear consensus provided in the literature concerning the terminology, aetiology and the treatment part of pain in the anterior aspect of the knee. Anterior knee discomfort suggested encompassing all pain-related problems. By excluding anterior knee pain that is due to intra-articular pathology, peripatellar tendinitis or bursitis, plica syndromes, Sinding Larsens disease, Osgood Schlaters disease, neuromas and other rarely occurring pathologies, it is suggested that remaining subjects with some clinical presentation of anterior knee pain could be diagnosed with a patella-femoral pain syndrome (PFPS). Three major factors that are contributing for PFPS are

(i) Malalignment of the lower limb and/or the patella;

(ii) Muscular imbalance of the lower extremity (strong antagonistic muscle with an weak agonist muscle can contribute to the imbalance)

(iii) Overactivity.

The significance of lower limb alignment factors and pathological limits that needs further investigation is discussed in this study. It is possible that the definitions used for malalignment should be re-evaluated, as the scientific support is very weak for determining when alignment is normal and when there is malalignment. Consequently, pathological limits must be clarified, along with evaluation of risk factors for acquiring PFPS.

Muscle tightness and muscular imbalance of the lower extremity muscles with decreased strength following hypotrophy or inhibition have been suggested, but remain unclear as potential causes of PFPS. Decreased knee extensor (quadriceps) strength is a common finding in patients with PFPS.

Various patterns of weaknesses have been reported, with exclusive weakness in eccentric muscle strength, within the quadriceps muscle and in the terminal knee extension. The significance of muscle function in a closed kinetic chain versus open kinetic chain has been discussed, but is far from well investigated. It is clear that further studies are necessary in order to establish the significance of various strength deficits and muscular imbalances,
and to clarify whether a specific disturbance in muscular activation is a cause or an effect (or both) of PFPS.

The most common symptom in patients with PFPS are pain during and after physical activity, during body weight loading of the lower extremities in walking up/down stairs and squatting, and in sitting with the knees flexed. However, the source of patellofemoral pain in patients with PFPS cannot be sufficiently explained. There are several types of clinical manifestation of pain, and therefore a differentiated documentation of the patients pain symptoms is necessary. The connection between strength, pain and inhibition, as well as between personality and pain, needs further investigation.

Many different treatment protocols are described in the literature and recent studies advocate a comprehensive treatment approach allowing for an individual and specifically designed treatment. Surgical treatment is rarely indicated. It is strongly suggested that, when presenting studies on PFPS, a detailed description should be provided of the diagnosis, inclusion and exclusion criteria of the patients should be specified along with a detailed methodology, and the conclusions drawn should be compared with those of other studies in the published literature.

As this is not the case in most studies on PFPS found in the literature, it is only possible to make general comparisons. In order to further develop treatment models for PFPS we advocate prospective, randomised, controlled, long term studies using validated outcome measures. However, there is a strong need for basic research on the nature and aetiology of PFPS in order to better understand this mysterious syndrome.

This cross-sectional study was done in outpatient, STUTI department of physiotherapy and N.R institute of physiotherapy, Bapunagar, Ahmedabad.

The sample for the study was calculated using the following strategy where there are few assumptions in order to calculate required sample size including variability, type I error and type II errors along with the smallest effect of interest. The variability in the study outcome variable is considered the population variance of the outcome that is estimated by standard deviation. Though the investigators can use an estimate obtained from already published pilot study our study considered the following method for sample size estimation because of type I and type II errors.
The type I error is a scenario where the researcher reject a true null hypothesis and type II error is where the researcher fail to reject the false null hypothesis. The type I error is corresponding to the exact level of confidence in sample size estimation, which is nothing but the degree of uncertainty or probability that the sample size lies outside a stated limits. The type II error is in corresponding to the power, which means the capacity of a statistical test to decline the false null hypothesis. Power analysis was done for the study to calculate the minimum sample size so that the investigator can be able to detect an effect of the given size.

In our cross-sectional studies the aim was to estimate the prevalence of an unknown parameter from the target population by using a random sample method. Hence adequate sample size is needed to estimate the population prevalence with a good precision. To calculate an adequate sample size for this phase of the study a standard formula was used, however it needed some practical issues in preferring values for the assumptions needed in the formula too and in some instances, the decision to select the appropriate numbers for the assumptions are not simple. The following standard formula was used for the study to calculate the adequate sample size in the current cross sectional phase of the study; (Mohamad Amin Pourhoseingholi, 2013)

\[
N = \frac{Z^2 \cdot P(1-P)}{d^2}
\]

Where

N is the sample size,

Z is the statistic corresponding to level of confidence,

P is expected prevalence (that can be obtained from similar studies conducted on the same relevant topic by the researchers), and

d is precision (corresponding to effect size).

The level of confidence used for the study is 95%.

The above mentioned P value for the calculation was collected from the study done by Brian Noehren and Logan Shuping et al in 2016. They studied the Somatosensory and Biomechanical Abnormalities in subjects with Patellofemoral Pain as a cross sectional study. (The Clinical Journal of Pain. 32(10):915-919, OCT 2016). This article was so relevant to our current study as both being an cross sectional study dealt with pain associated with PFPS.
As the study commenced during 2016 this study was considered most recent by the researcher. The thus calculated sample requirement was 47 and the same was rounded off to 50 numbers of samples for the screening.

50 Patients were selected using convenient sampling method. This study included both male and female patients aged between 20-40 years who had gradual onset of first episode knee pain which lasted for more than 4 weeks. This age group was selected because the onset of knee pain was very rare below 20 and the condition often attains chronicity beyond 40 years of age with altered biomechanical angles secondary to musculoskeletal, neuro muscular failure and compensatory attitude of patients or even demineralisation of bones beyond 40 years which is part of aging.

The patients having history of knee pain during ascending or descending stairs, jogging or hopping activity or prolonged cross leg sitting, prolonged kneeling or prolonged squatting were also inclusion. In addition to the above criteria patients who were diagnosed as PFPS for the first time and referred to physiotherapy department by an orthopaedician were also included. Subjects who had pain on palpation of medial or lateral patellar facets, Pain on resisted isometric extension, a positive Clarke’s sign were also selected.

The subjects for the study were selected from STUTI department of physiotherapy and N.R institute of physiotherapy, Bapunagar, Ahmedabad Patients who had a previous history of hip/knee/ankle surgery/fractures, Traumatic onset of Patello Femoral pain syndrome, Neurological symptoms, Leg length discrepancy, Exhibited a positive response to Apley’s compression test, Lachman test, posterior drawer test, apprehension test for patellar subluxation or varus/valgus stress tests for collateral ligament damage, Peri patellar bursitis or tendonitis and Systemic arthritis were excluded from the study. Subjects who fulfilled the above criteria were included for the study. Subjects were screened until 50 subjects were recruited for the study. A total number of 165 subjects were screened for the study.
3.5 Procedure:

Prior to data collection, demographic data including age, gender, height, weight, previous history of knee problems, mechanism of injury, current episode duration, and symptom location was recorded and self-reported measure of pain was taken from each participants using pain severity scale for PFPS. A complete physiotherapy examination was conducted on the subjects as follows

First the subjects were analysed for their chronological data like age, sex, occupation, contact details and so on. The next interaction with the patient was asking for the chief complaint. The chief complaint was documented in patient’s language specifying the order of problems in a hierarchical manner and specifying the duration of the ailment. An open ended question was used to investigate patient chief complaint rather than a closed ended question. Researcher believe that an open ended question can bring out more informations from the subject that will be very useful for the study.

Based upon the chief complaints, a detailed subjective and objective examination was performed. The assessment was a hypothesis driven one, the researcher came to an idea about the ailment of the patient with subjective examination. With this idea, he named name the hypothesis and the hypothesis was tested using structured objective examination pattern. In the subjective examination the researcher asked questions about the present and past medical history which was relevant to the condition.

A detailed pain examination was conducted as follows. The onset of the pain was documented to know weather the pain was a sudden onset or insidious onset. With this information the researcher was able to find out whether it was a traumatic or inflammatory or a degenerative condition. The duration of ailment was measured using a time frame. This clearly gave an idea to the researcher about the chronicity of the condition. Aggravating factor was asked for knowing any movement or position facilitated the pain. Relieving factors were asked for finding out the appropriate posture, activity or medication that relieve the pain. Knowing the aggravating movements, researcher performed those moments at last, to prevent interference of pain elicited by such movements while performing other normal moments.

Research asked for the type of pain, which gave him an idea about whether the underlying impairment is with bone, muscle, nerve or blood vessels extra. The researcher
asked for the nature of pain weather it was intermittent or continuous to know whether it is of traumatic origin or degenerative origin. The researcher ask for 24 hour pattern of pain to know whether the pain is inflammatory in nature which normally presents as pain in early morning. The researcher asked how severe was the pain using a numerical pain rating scale, where the least score was signifying no pain and the maximum score signify worst pain. The patients were asked to choose a number of his choice corresponding to the pain severity.

Patients were questioned about the irritability factor, which signified how the pain influence the patients activity of daily living, whether the patient was able to perform all their day to day activity when there is a pain onset. After completing the subjective examination and the pain examination the researcher came to conclusion about what might be the problem and specified that as his hypothesis.

In the objective examination the subjects were assessed for the motor system first. An examination of the muscle strength in concentric and isometric type of muscle contraction were tested and graded grading from 0 to 5. The deep tendon reflexes were examined to know the integrity of spinal control centres of motor system and the supraspinal influence on the same. The muscle tone was measured and if the patient had apprihension to movement this was not performed. Later a sensory examination was performed for superficial sensation of touch temperature and pain.

The musculoskeletal examination was performed, assessing for the active and passive range of motion of knee, hip and ankle. The endfeel of knee flexion and extension was assessed and if there was a restricted in range of motion the pathological end feel was analysed and so was the presence of capsular pattern. Special tests pertaining to knee were performed to find out the specific structure that was injured or impaired. These tests were essential to differentiate PFPS from other conditions that can provoke anterior knee pain, without being PFPS.

Chondromalacia Patellae, Hoffa's pad syndrome, Iliotibial band friction syndrome, Sinding-Larson-Johansson syndrome, Patellar tendinitis, Osteoarthritis in the knee, Chondral lesions, medial meniscus tears, Medial overload syndrome, Popliteal Cyst (Baker's Cyst), ACL (anterior cruciate ligament) tear, PCL injury/rupture, Referred pain from the hip joint and Referred pain from lumbar spine. The special tests performed for the study were as follows.
Step-Down Test

A step-down test was performed to assess hip and leg power and endurance. The subjects were asked to stand on a 20 cm box using the leg to be tested. Subjects stood with arms folded across their chest and were instructed to squat down using one lower extremity for 5-10 times consecutively, in a controlled smooth and slow manner until the heel touches the ground, maintaining their balance with a rate of approximately 1 squat per 2 seconds. To be considered good the patient must have shown none of the deviations in 4 of the 5 criterion listed in table 3.1.

<table>
<thead>
<tr>
<th>Overall Impression</th>
<th>Trunk</th>
<th>Pelvis</th>
<th>Hip</th>
<th>Knee</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maintain balance</td>
<td>Lateral deviation/shifting</td>
<td>Lateral rotation</td>
<td>Adduction</td>
<td>Valgus</td>
</tr>
<tr>
<td>Perturbation</td>
<td>Rotation</td>
<td>Rotation</td>
<td>Internal rotation</td>
<td>Varus</td>
</tr>
<tr>
<td>Depth of movement</td>
<td>Lateral flexion</td>
<td>Tilt</td>
<td></td>
<td>Position relative to foot</td>
</tr>
<tr>
<td>Speed of movement</td>
<td>Forward flexion</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 3.1 - Step Down Test Alterations
Those who had decreased onset timing of the anterior gluteus medius, who had decreased hip abduction torque and who had decreased lateral trunk strength were rated as poor compared to those with good scores.

**Lateral Step Down Test**

Rabin et al developed a scoring system to rate the lateral step-down test (Table 3.2). The lateral step-down test is nothing but a modified standard step-down test in which the movement is lateral instead of anterior. The instructions for the lateral step down test were as follows: patient were instructed to stand with involved leg on a 15 cm stool. This required a knee flexion at about 60 degrees. Patients were asked to reach down to touch the opposite side, the non-involved heel to the ground, and then instructed to return to the starting position. Patient were asked to rated on the criterion listed in Table 3.2. The participants with PFPS were scored good (score, 0-1) or moderate (score 2 or greater). Subjects who were scored moderate scores exhibited limitation in dorsiflexion range of motion and compromised hip external rotation and diminished knee extension strength.

<table>
<thead>
<tr>
<th><strong>Criterion</strong></th>
<th><strong>Interpretation</strong></th>
<th><strong>Score</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Arm strategy</td>
<td>Removes hands from waist</td>
<td>1</td>
</tr>
<tr>
<td>Trunk alignment</td>
<td>Leaning in any direction</td>
<td>1</td>
</tr>
<tr>
<td>Pelvic plane</td>
<td>Loss of horizontal plane</td>
<td>1</td>
</tr>
<tr>
<td>Knee posture</td>
<td>Tibial tuberosity medial to 2\textsuperscript{nd} toe</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Tibial tuberosity medial to medial border of foot</td>
<td>2</td>
</tr>
<tr>
<td>Steady</td>
<td>Stepping down on non-tested limb, or wavering from side to side</td>
<td>1</td>
</tr>
</tbody>
</table>

*Table 3.2. Scoring for Lateral Step-Down Test*
Both superficial and deep patellar retinacula were assessed in supine position. Passive patellar glides were performed to assess the state of superficial lateral retinaculum and were performed with the knee flexed to 30 degrees. Though many report that testing should be done with knee in full extension, we felt that testing in full extension will only examine the peripatellar soft tissue passive mobility predominantly. The researcher preferred position was 30 degrees of knee flexion as he perceived that patella has started to enter into the trochlea and will provide a functionally stable position. While the knee is in this position of slight flexion the researcher can not only feel the resistance from soft tissues, but also resistance from the bony engagement of the patella, because most commonly patellar dislocations takes place in this range, therefore its proved to be a functional position of testing.

In our study to perform the passive patellar glide test, the patient’s relaxed knee was placed in 30 degrees of flexion using a bolster. Subject’s relaxation was very vital to obtain accurate results from this test. As even a slightest amount of guarding will diminish the amount of patellar mobility the subjects were requested to cooperate. The researcher, positioned on the lateral side of the subject’s knee, will used their thumbs for passively glide the patella towards the medial direction. The researcher then moved his hands to the medial side of the knee and repeated the same technique to analyse the lateral mobility.

The lateral glide is called interchangeably as the Fairbank’s sign or knee apprehensive test. Therefore, it was performed after the medial glide testing. The amount of patellar tilt was kept constant during testing, as altering patellar tilt will change the soft tissue mechanics. When tilting was not controlled we found that the patella rotated more giving the appearance of a translation which was actually rotation.

The researcher estimated the amount of translation through dividing the patella into longitudinal quadrants and then estimating the degree of number of quadrants worth of translation that was achieved during examination. Two quadrants of passive mobility were considered normal.

After this Physical examination, the following measurements were carried out. Femoral ante-version was measured using the Craig’s test with the participant in the prone position and knee flexed to 90°. The examiner palpated the posterior aspect of the greater trochanter of the femur. The hip was then passively rotated until the most prominent portion
of the greater trochanter reached the horizontal plane. The degrees of anteverision were then estimated based on the angle of the lower leg with the vertical line.

Q-angle was measured with the knee in full extension and the subject in supine. The angle formed by the intersection of the line of application of the quadriceps force with the anterior line of the patellar tendon was measured in degrees with a universal goniometry. The center of the patella and the tibial tubercle was marked with a demographic pencil, which was erased after the measurement.

The patient was then made to perform a lateral step down test. Quality of movement during the lateral step down test was assessed using a scale design for this purpose. The subject was asked to stand in single limb support with the hands on the waist, the knee straight and the foot position closed to the edge of a 20 cm high step. The contra lateral leg was made positioning over the floor adjacent to the step and was maintained with the knee in extension. The subject bent the tested knee until the contra lateral leg gently contacted the floor and then re-extended the knee to the start position. These manoeuvres were repeated for 5 repetitions.

The examiner assessed the subject and scored the test based on 5 criteria: 1) Arm strategy: when subject used an arm strategy in an attempt to recover balance, 1 point was added; 2) Trunk movement: when the trunk leaned to any side, 1 point was added; 3) Pelvis plane: when pelvis rotated or elevated one side compared with the other, 1 point was added; 4) Knee position: when the knee deviated medially and the tibial tuberosity crossed an imaginary vertical line over the 2nd toe, 1 point was added, or if the knee deviated medially and the tibial tuberosity crossed an imaginary vertical line over the medial border of the foot, 2 points were added, and; 5) Maintain steady unilateral stance: if the subject stepped down on the non-tested side, or if the subject tested limb became unsteady, 1 point was added. Total score of 0 or 1 was classified as good quality of movement, total score of 2 or 3 was classified as medium quality and total score of 4 or above was classified as poor quality of movement.

Hamstrings length was determined by measuring the straight leg raise using a gravity goniometer. The subject was made to lie in supine position with the tested knee extended and the other leg flat on the table to avoid excessive posterior pelvic tilt. Before starting the measurement, the goniometry was zeroed on the lower half of the anterior border
of the tibia. Then, the lower extremity was passively lifted to the end range of motion or firmend feel and the measurement was recorded in degrees. The average measurements of two trials with 5-second pause between trials were recorded.

Foot pronation was measured by the navicular drop test which measures the difference between height of the navicular at subtalar joint neutral position and that of the relaxed stance position. The examiner positioned the subtalar joint in neutral position. An index card was placed perpendicular to the table, the examiner recorded the distance from the navicular to the floor.

The subject was then instructed to relax from the subtalar neutral position and the measurement was repeated. Then, with a metric ruler, the distance between the two dots, in the index card was recorded in millimeters. Pain severity was assessed using pain severity scale for patello-femoral pain syndrome. The Confirmatory tests used were Craig’s test, Straight leg test/ active knee extension test, Q-angle, Lateral step down test and Navicular drop test.
(FIG: 3.1. Nevicular Drop Test)
(FIG: 3.2. Craig’s test)
(3.3) Q-angle test

(FIG. 3.4) Q-angle test
(FIG: 3.5. Straight leg test)

FIG: 3.5.1 Straight leg test
(3.6. Ultrasound in knee joint)
(3.7. Ultrasound)
(3.8. Q-drill exercise)
(3.9. Last 15 degree extension)
(3.10. Quadricep chair exercise)
(3.11 Thera band exercise)
(3.12. Thera band exercise)
(3.13. Quadricep strengthening exercise)
(3.14. Quadricep strengthening exercise)
(3.15. Thera band exercise in long sitting position)
(3.16. LATERAL STEP DOWN TEST)
(3.17. LATERAL STEP DOWN TEST)
(3.18 Knee press exercise)
(3.19 Tapping for PFPS)

(3.19.1 Tapping for PFPS)
(3.20. Half squatting)

(3.21. Knee extension)
Data collection Tool:

1. Craig’s test – for measuring femoral anteversion.
2. Straight leg test – for measuring hamstring length.
6. NPRS – for measuring the severity of pain.
3.6. Results

All the data were collected by the primary researcher and saved in computerised form in an excel sheet. The confidentiality of the data was maintained by the researcher. The results for the study were analysed using SPSS software. The demographic data of the participants are tabulated and displayed in table 1. The average values of the outcome tools were expressed in mean and standard deviation (table 2).

The dependent variable for the study was severity of pain and the independent variables were Craig’s test for measuring Femoral ante- version, Straight leg test – for measuring hamstring length, Q- angle – for measuring patellar position, Lateral step down test – for measuring quality of movement, Navicular drop test – for measuring foot pronation, NPRS – for measuring the severity of pain. Since the researcher wanted to explore the relation between the dependent and independent variable a Chi square test was performed.

In the analysis of association between Craigs angle and NPRS the value of R was 0.8682. This is a strong positive correlation, which means that high Craigs angle scores higher was NPRS scores (and vice versa). The value of R2, the coefficient of determination, was 0.7538. Figure 1 explains the relationship between NPRS and Craigs angle in a more clear pictorial form.

In the analysis of association between Q angle and NPRS the value of R was 0.9248. This is a strong positive correlation, which means that high Craigs angle scores higher was NPRS scores (and vice versa). The value of R2, the coefficient of determination, was 0.8553. Figure 2 explains the relationship between NPRS and Craigs angle in a more clear pictorial form.

In the analysis of association between SLR and NPRS the value of R was -0.1449. Although technically a negative correlation, the relationship between your variables is only weak. The value of R2, the coefficient of determination, was 0.021. Figure 3 explains the relationship between NPRS and SLR in a more clearly pictorial form.

In the analysis of association between Navicular drop scale and NPRS the value of R was 0.9607. This is a strong positive correlation, which means that high navicular drop scores higher was NPRS scores (and vice versa). The value of R2, the coefficient of determination, was 0.9229. Figure 4 explains the relationship between NPRS and Navicular drop scale in a more clear pictorial form.
In the analysis of association between lateral step test scale and NPRS the value of R was 0.0589. This is a strong positive correlation, which means that high navicular drop scores higher were NPRS scores (and vice versa). The value of R², the coefficient of determination, was 0.0035. Fig 5 explains the relationship between NPRS and Craigs angle in a more clear pictorial form.

<table>
<thead>
<tr>
<th>DATA</th>
<th>MEAN±SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>SUBJECTS</td>
<td>n = 50</td>
</tr>
<tr>
<td>AGE</td>
<td>30.2 ± 5.74</td>
</tr>
<tr>
<td>SEX</td>
<td>M=29, F = 21</td>
</tr>
<tr>
<td>BMI</td>
<td>22.69 ± 1.89</td>
</tr>
<tr>
<td>ACTIVITY LEVEL</td>
<td>sedentary - 12, mild - 09, moderate - 19, heavy - 10</td>
</tr>
</tbody>
</table>

Table 3.1 – The demographic data of the participants.
<table>
<thead>
<tr>
<th>Parameters</th>
<th>Mean (M)</th>
<th>Standard Deviation (SD)</th>
<th>Number of subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>SLR</td>
<td>50.7000</td>
<td>5.57051</td>
<td>50</td>
</tr>
<tr>
<td>Q-ANGLE</td>
<td>15.0640</td>
<td>.97314</td>
<td>50</td>
</tr>
<tr>
<td>LAT STEP</td>
<td>34.9500</td>
<td>2.17183</td>
<td>50</td>
</tr>
<tr>
<td>NAVICULAR DROP</td>
<td>10.0800</td>
<td>1.66831</td>
<td>50</td>
</tr>
<tr>
<td>CRAIG'S TEST</td>
<td>11.2250</td>
<td>1.61342</td>
<td>50</td>
</tr>
<tr>
<td>NPRS</td>
<td>3.8000</td>
<td>1.08797</td>
<td>50</td>
</tr>
</tbody>
</table>

Table 3.2 – screening tools and their average values (Mean and standard deviation values)

<table>
<thead>
<tr>
<th>Model</th>
<th>R</th>
<th>R Square</th>
<th>Adjusted R Square</th>
<th>Std Error of the Estimate</th>
<th>Change Statistics</th>
<th>R Square Change</th>
<th>F Change</th>
<th>df1</th>
<th>df2</th>
<th>Sig. F Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>.429*</td>
<td>.184</td>
<td>.092</td>
<td>1.03697</td>
<td></td>
<td>.184</td>
<td>1.988</td>
<td>5</td>
<td>44</td>
<td>.099</td>
</tr>
</tbody>
</table>

a. Predictors: (Constant), CRAIG TEST, LATERAL STEP, NAVICULAR DROP, SLR, Q ANGLE

b. Dependent Variable: NPRS

Table 3.3. R and R square values for change in NPRS based on other biomechanical criterions
Fig 3.1—Correlation between NPRS and Craigs angle.
Fig 3.2 – Correlation between NPRS and Q angle.
Fig 3.3 — Correlation between NPRS and SLR.
Fig 3.4 – Correlation between NPRS and Navicular drop scores.
Fig 3.5 – Correlation between NPRS and lateral step test score.
3.7. Discussion

Numerous risk factors for knee pathology, progression and prognosis have been identified through large epidemiological studies. Yet, the relationships among them are not well illustrated. (Minor MA, 2007) This is largely attributed to the multifactorial nature of the disease process. (Brandt KD, 1998) Numerous mechanical factors have been linked to the progression of knee OA, particularly excessive joint loading and the magnitude of the knee adduction moment during gait (Miyazaki, 2002 and Mundermann A, 2005), which has been associated with loading in the medial compartment of the knee joint (Zhao D et al, 2007). Recent literature provides a compelling argument for using gait as a model to understand the loading environment of the joint (Andriacchi TP et al, 2009). Dynamic loading occurs with higher frequency during gait than other activities of daily living, and walking is the activity most commonly reported as difficult by those with knee OA (Guccione AA et al, 1994). Obesity is another particularly prevalent risk factor for knee OA, that has been linked to the mechanical degeneration of the joint (Messier et al, 2000)

PF arthritis is a progressive disease, with changing biomechanics at different levels of clinical severity (Astephen JL, 2008). Many biomechanical investigations of knee OA have focused on subjects with severe knee OA but results of these studies are often confounded with the concomitant changes of the end stages of the disease process and tell us little of the underlying pathomechanics. (Deluzio KJ, 2007) Investigations of the biomechanics of more mild to moderate levels of disease severity can provide better information on the pathomechanical processes of disease progression. Some recent studies have compared the gait patterns of asymptomatic and moderate knee OA subjects, and between discrete radiographic levels of severity in individual with moderate OA. However, these studies often focus on individual factors of the disease and rarely consider the potentially important interactions between factors. As well, disease severity classifications often based on a discrete, categorical radiographic criterion such as the Kellgren Lawence global radiographic score, which is limited in sensitivity to four discrete categories. The KL score is a blunt measure of radiographic severity because each level can describe joints with a range of radiographic changes, and it has been suggested that mild osteophyte formation alone may represent age-related bone modeling as opposed to a disease process. A more continuous structural severity rating by an experienced clinician, such as those used
extensively in the measurement of clinical pain, could provide a more continuous metric of structural disease severity for which to compare mechanical changes.

There is a known discrepancy between the radiographic and symptomatic expression of knee OA, suggesting that the structural degeneration of the joint and symptomatic progression of the disease are likely associated with different biomechanical factors. While some studies have examined the association between biomechanical factors and radiographic and pain severity, there are some conflicting results, particularly regarding the association of the knee adduction moment during ait and pain (Hurwitz DE, 2002 and Maly MR, 2008). As well, few studies have examined the association between neuromuscular control patterns and radiographic and symptomatic severity.

In the present study, a correlation is drawn between the severity of the pain and five important biomechanical considerations which the researcher feels may influence the pain severity associated with PFS. Femoral anteversion was calculated using craig’s test because it is proved in the past that femoral orientation particularly the distal 1/3 influences the position of patella and its mobility. In the current study, the analysis of the data showed that there was a strong influence of the distal femur orientation with severity of pain, the severity of pain increased exponentially with every increase in femoral anteversion. The results of the similar studies in the past which has stated that most of the PF arthritis had altered femoral anteversion. In a study done by Stambough in 2018, it is proved obviously that femoral derotation osteotomy has significantly reduced PF pain which establishes the significance of femoral anteversion.

Patella is the largest sesamoid bone formed from the tendon of quadriceps and thus depends on quadriceps for its positioning. The Q angle is the one which indicates the position of patella. In the current study it is proved that there is a stronger relationship between q angle and PF pain. The association is greater than the craig’s angle which explains the importance of Q angle in determining PF pain.

Insall J Salvati studied the importance of position of patella and came out with two condition namely patella Alta and patella Baja which significantly contributed for pain around knee joint. Results of the current study are in line with study done by zang D et al in 2011 who explained that the patella position in transvers plane and frontal plane plays a major role in preserving the articular cartilage of the Patello femoral joint.
Straight leg raising (SLR) is proved to be important test determining the neuromuscular integrity of the lower limb. SLR is an important test performed to determine pathology of lumbar joint (Seaia 2012), hip joint and sacroiliac joint (Kibs Gard 2017). But the role of SLR in determining knee pain is not much known. The current study tried to explore the relationship between SLR and pain severity and found out that there was no correlation between the two. This can be explained by the fact that SLR is a neural tension testing and to sum extent test the integrity of hip and knee joint. Hence SLR do not have much role to play with the Patello femoral joint. Navicular drop test was incorporated in the study to find out whether the distal part of the foot had a influence on patellofemoral pain. it is very evident from the study done by Zuil-escobar that navicular drop test significantly influences the medial longitudinal arch and determines the weight distribution on the plantar aspect of the foot.

He also claimed that the navicular position also influences the distal foot and thereby the knee joint aswell. Considering these valid points, the current study tried to examine the relationship between the navicular drop test and pain severity and proved that there was a strong positive correlation between the same which clearly states that navicular drop scale have a telling influence on pain associated with PFPS.

Lateral step test which was found to be a predictor of quality of movement in the hip, knee and ankle joints (Rabin A et al 2016). The analysis of the current study states that there was no correlation between lateral step test score and severity of pain of Patello femoral joint. This phenomenon can be explained by the fact that lateral step test is a test used to assess the quality and stability of joint alone. As it is a test performed with less repetition it does not takes into consideration the decay in the quality of movement and its consequences on a longer run.

3.8 Conclusion

This phase of the study concludes from the correlative analysis performed between 5 biomechanical variables and severity of PFP that navicular position, Q angle and femoral anteversion influences the severity of pain in the given order respectively. It is also recommended from this phase that any intervention attesting Patellofemoral joint pain should consider these three factors in bringing about a better and a faster recovery.
PHASE 2 – Effect of biomechanical approach in management of PFPS

The Common physiotherapy interventions for the treatment of PFPS are Manual Therapy, open vs. closed chain exercises, Quadriceps strengthening, Patellar Taping, Orthotics, Proximal Muscle strengthening, Modalities. But in this study it is debated that the current treatments lack support by current evidence.

The following conclusions have been drawn after an extensive literature survey. No significant difference was noted in open vs. closed chain exercises with respect to exercise type, further evidence is needed to investigate the long term effects of patella taping, the mechanism of action and direction of force (medial, neutral, lateral).

Clinical evidence for the success of this intervention is still unclear due to an insufficient amount of high level evidence, inconsistency of tape application techniques, in ability to identify the precise mechanism of action, and variance in measurements of specific outcome variables. In the literature there was no data available regarding the physiology and benefits of massage, an no conclusive evidence for thermotherapy, TENS, electrical stimulation, and biofeedback for treatment of PFPS.

So when raising a question What treatments are supported by the best available evidence?

We found the following answers through literature which helped us in framing the intervention for the current study. The role of hip muscle function in the treatment of PFPS was emphasised. More success rate occurred with hip flexor strength improvements and normalization of IT band/tensor fascia latae. Attesting the weakness of hip abductors, extensors and external rotators in testing of patients with PFPS.

Treatment consisted of recruitment and endurance training of the hip, pelvis, and trunk musculature which resulted in a significant reduction in pain, improved L.S kinematics during dynamic testing and ability to return to original level of function. The effectiveness of daily patella taping and exercise on pain and function in individuals with PFPS was immense. Results suggest that patella taping may be useful in conjunction with strengthening exercise to enhance speed of recovery.

The effect of foot orthoses on PFPS was also proved to be effective. Many studies suggest that the use of orthotics in patients who present with excessive pronation resulted
in improved pain/stiffness (note: multiple interventions were used in these studies, including orthosis). Patients with patellofemoral pain may benefit from the use of foot orthosis if the patient demonstrates the following: excessive foot pronation and/or a LE alignment profile that includes excessive lower extremity internal rotation during weight bearing and increased Q-angle. Additional studies were needed to assess the treatment efficacy of foot orthosis for patients with PFPS.
3.9. Methodology

This randomized control trial was done in outpatient, STUTI department of physiotherapy, Bapunagar, Ahmedabad. 30 Patients were selected using convenient sampling method. This study included both male and female patients aged between 20 to 40 years who had gradual onset of first episode knee pain which lasted for more than 4 weeks. The patients having history of knee pain during ascending or descending stairs, jogging or hopping activity or prolonged cross leg sitting, prolonged kneeling or prolonged squatting were also inclusion.

Inclusion criteria:

Age: 20-40 years (This age group was selected because the onset of knee pain was very rare below 20 and the condition often attains chronicity beyond 40 years of age with altered biomechanical angles secondary to musculoskeletal, neuro muscular failure and compensatory attitude of patients or even demineralisation of bones beyond 40 years which is part of aging
  1. Males and Females
  2. 1st episode of knee pain
  3. Gradual onset
  4. Duration of signs and symptoms greater than 4 weeks
  5. History consistent with PFPS like Retro-patellar knee pain during at least two of the following activities: ascending/descending stairs, hopping/jogging, prolonged sitting with flexed knees, kneeling, and squatting
  6. Pain on palpation of medial or lateral patellar facets
  7. Pain on resisted isometric extension
  8. Clarke’s sign
  9. Participation in any sport activity for the duration of 6 weeks ≥1 year

F. Exclusion criteria:

1. History of previous hip/knee/ankle surgery/fractures
2. Traumatic onset of PF pain syndrome
3. Neurological symptoms
4. Leg length discrepancy
5. Exhibited a positive response to Apley’s compression test, Lachman test, posterior drawer test, apprehension test for patellar subluxation or varus/valgus stress tests for collateral ligament damage
6. Peri patellar bursitis or tendonitis
7. Systemic arthritis

Apart from all the above criteria the physiotherapist performed the following assessment to objectively conclude that the subject was suffering with PFPS. The subjects were asking for the chief complaint. The chief complaint was documented in patient’s language specifying the order of problems in a hierarchical manner and specifying the duration of the ailment. An open ended question was used to investigate patient chief complaint rather than a closed ended question. Researcher believe that an open ended question can bring out more informations from the subject that will be very useful for the study.

Based upon the chief complaints, a detailed subjective and objective examination was performed. The assessment was a hypothesis driven one, the researcher came to an idea about the ailment of the patient with subjective examination. With this idea, he named name the hypothesis and the hypothesis was tested using structured objective examination pattern. In the subjective examination the researcher asked questions about the present and past medical history which was relevant to the condition.

A detailed pain examination was conducted as follows. The onset of the pain was documented to know whether the pain was a sudden onset or insidious onset. With this information the researcher was able to find out whether it was a traumatic or inflammatory or a degenerative condition. The duration of ailment was measured using a time frame. This clearly gave an idea to the researcher about the chronicity of the condition. Aggravating factor was asked for knowing any movement or position facilitated the pain. Relieving factors were asked for finding out the appropriate posture, activity or medication that relieve the pain. Knowing the aggravating movements, researcher performed those moments at last, to prevent interference of pain elicited by such movements while performing other normal moments.

Research asked for the type of pain, which gave him an idea about whether the underlying impairment is with bone, muscle, nerve or blood vessels extra. The researcher
asked for the nature of pain weather it was intermittent or continuous to know whether it is of traumatic origin or degenerative origin. The researcher asked for 24 hour pattern of pain to know whether the pain is inflammatory in nature which normally presents as pain in early morning. The researcher asked how severe was the pain using a numerical pain rating scale, where the least score was signifying no pain and the maximum score signify worst pain. The patients were asked to choose a number of his choice corresponding to the pain severity.

Patients were questioned about the irritability factor, which signifyd how the pain influence the patients activity of daily living, whether the patient was able to perform all their day to day activity when there is a pain onset. After completing the subjective examination and the pain examination the researcher came to conclusion about what might be the problem and specified that as his hypothesis.

In the objective examination the subjects were assessed for the motor system first. An examination of the muscle strength in concentric and isometric type of muscle contraction were tested and graded grading from 0 to 5. The deep tendon reflexes were examined to know the integrity of spinal control centres of motor system and the supraspinal influence on the same. The muscle tone was measured and if the patient had apprihension to movement this was not performed. Later a sensory examination was performed for superficial sensation of touch temperature and pain.

The musculoskeletal examination was performed, assessing for the active and passive range of motion of knee, hip and ankle. The endfeel of knee flexion and extension was assessed and if there was a restricted in range of motion the pathological end feel was analysed and so was the presence of capsular pattern. Special tests pertaining to knee were performed to find out the specific structure that was injured or impaired. These tests were essential to differentiate PFPS from other conditions that can provoke anterior knee pain, without being PFPS:

Sampling technique

The subjects for the study were selected from STUTI department of physiotherapy and N R institute of physiotherapy, Bapunagar, Ahmedabad.

In this phase of the study a Randomised control trail was used to find the effect of biomechanical approach in the management of PFPS. The subjects were randomly assigned into two groups namely, group A and group B with 15 subjects in each group using random number table and concealment method using an opaque cover. Group A received conventional exercises in the form of ultrasound therapy to the patellar tendon, taping and strengthening exercise of the hamstrings and quadriceps. Group B received conventional set of exercises that received by group A and also Bio mechanical approach and postural correction Therapy. Outcome measures were used on the baseline measurements before the intervention. Post-test value was collected at the end of first second and third week of intervention. Outcome measures that were used are numerical pain rating scale, Mc Gill pain questionnaire, anterior knee pain scale, WOMAC scale.
The sample size for the study was calculated using the following technique

As the RCT has two comparison groups and both groups have the same size of subjects; sample size calculation depends on the type of primary outcome measures. The following formula was used for calculating the sample size.

\[ N = 2 \times \left( \frac{z_{1-\alpha} + z_{1-\beta}}{d - \delta_0} \right)^2 \times p \times (1 - p) \]

**Parameter definitions**

N= size per group;

p= the response rate of standard treatment group;

\( z_x \) = the standard normal deviate for a one or two sided \( x \);

\( d \) = the real difference between two treatment effect;

\( \delta_0 \) = a clinically acceptable margin;

\( S^2 \) = Polled standard deviation of both comparison groups.

3.10. Intervention

Subjects in group A received ultrasound therapy (UST) for patellar tendon. The parameters for UST selected were based upon the researcher’s choice which was based upon the chronicity of the ailments. The duration of treatment was 8 minutes with an intensity 2.5 watts/cm². Strengthening exercises were provided to quadriceps and hamstring and also muscles of hip, using Delorme boot, therabands and quadriceps table.

Tapping technique was provided for subjects who had abnormal positioning of patella. The first step was to clean the area that was to be taped with an alcohol swab, next palpating the patella, then applying white cover strip and finally apply McConnell tape (also known as leukotape) this was performed to Reduces pain during activity, Corrects mal-alignment of the patella, to improves activation of the VMO and Aids in healing.

The total duration of the intervention was for 40 minutes (8 minutes of UST and 32 minutes of exercise therapy) with maximum 5 minutes of rest period. The intervention was carried out for once a day 5 days in a week for 3 weeks. Subjects in group B received UST with the duration of treatment was 8 minutes with an intensity 2.5 watts/cm².

The exercise therapy was based upon the biomechanical analysis in phase 1. Foot wear modifications were provided with navicular support to prevent navicular drop if the patient presented with excessive navicular drop. Q angle was analysed and efforts to correct them were taken in the form of attesting muscle imbalance among vastus lateralis and vastus medialis and using tapping for enhancing the desired effect. For correcting the increased femoral anteversion hip abductors were selectively strengthened in all three functional positions namely standing, sitting and lying. The total duration of the intervention was for 40 minutes (8 minutes of UST and 32 minutes of exercise therapy) with maximum 5 minutes of rest period.
3.11. Results

In this phase of the study four outcome measures were used namely NPRS, MCgill pain questionnaire, anterior knee pain and functional scale for patellofemoral joint. The outcome measures were analysed at the baseline at the end of first week, second week and third week. SPSS software was used to analyse data. The average values were expressed in mean and standard deviation. The between group analyses was done using independent t test. The post test analysis done at the end of 1st week, 2nd week and 3rd week were named as post test 1, post test 2 and post test 3. Within group analysis of the pre-test value and the three-post-test value was done using Freidman’s repeated measure analysis of variance on ranks. Dunn’s method was used to provide a multiple comparison between pre test and the three post test values. The confidence interval for this study was maintained at 95% with 3 degrees of freedom.

3.11.1. Analysis of NPRS

The between group analysis of NPRS for the pre-test value of group A and group B shows that there was no statistical difference (p value= 0.473) between both groups. With a mean and SD of 7.1 (1.76) and 7 (1.69) for group A and group B respectively. The between group analysis of post test 1, post test 2 and post test 3 showed a statistically significant difference between each other with a p value of 0.01 (post-test 1), 0.013(Post-test 2) and 0.01(post-test 3). In the entire three scores group B showed a significantly superior recovery than group A.

The within group analysis of group A using Freidman’s repeated measure analysis of variance on ranks showed that the difference in the mean values are greater than would be expected by chance $\chi^2$ value of 198.7 and a p value of 0.001. A Dunn’s analysis was done to draw multiple comparison which showed that there was no statistical difference between pre and post test 1(p=0.273) but there was statistical difference between pre and post test 2(p=0.042) and pre and post-test 3(0.01).

The within group analysis of group B using Freidman’s repeated measure analysis of variance on ranks showed that the difference in the mean values are greater than would be expected by chance $\chi^2$ value of 178.9 and a p value of 0.001. A Dunn’s analysis was done to draw multiple comparison which showed that there was statistically significant difference between pre and post-test 1(p=0.023), pre and post-test 2(p=0.001) and pre and post-test 3(p=0.001).
3.11.2 Analysis of McGill pain questionnaire

The McGill pain questionnaire for finding the intensity of pain (severity of pain) contains 6 questions with maximum score of 5 for each question and with a total score of 30. The baseline analysis of group A and group B for McGill Questionnaire showed that there was no statistical difference (p value= 0.564) between both groups, With a mean and SD of 18.6 (2.19) and 17.8 (2.27) for group A and group B respectively. The between group analysis of post-test 1, post-test 2 and post-test 3 showed a statistically significant difference between each other with a p value of 0.021 (post-test 1), 0.01(Post-test 2) and 0.01(post-test 3). In all the three scores group B showed a significantly superior recovery than group A.

The within group analysis of group A using Freidman’s repeated measure analysis of variance on ranks showed that the difference in the mean values are greater than would be expected by chance χ² value of 174.5 and a p value of 0.004. A Dunn’s analysis was done to draw multiple comparison which showed that there was no statistical difference between pre and post-test 1(p=0.432), pre and post-test 2(p=0.317) but there was statistical difference between and pre and post-test 3(0.041).

The within group analysis of group B using Freidman’s repeated measure analysis of variance on ranks showed that the difference in the mean values are greater than would be expected by chance χ² value of 167.4 and a p value of 0.003. A Dunn’s analysis was done to draw multiple comparison which showed that there was statistically significant difference between pre and post-test 1(p=0.032), pre and post-test 2(p=0.002) and pre and post-test 3(p=0.001).

3.11.3 Analysis of Anterior knee pain scale

The Anterior knee pain scale (Kujala scale) is a specific scale for anterior knee pain containing13 subsets with maximum score of 100 and a minimum score of 0, this is a self-reported knee specific questionnaire indicating greater disability or pain with a minimum score.

Group A and group B was measured for baseline analysis using anterior knee pain scale (Kujala scale) that showed there was no statistical difference (p value= 0.854) between both groups. With a mean and SD of 74 (6.3) and 72 (6.0) for group A and group B respectively. The between group analysis of post-test 1, post-test 2 and post-test 3 showed a
statistically significant difference between each other with a p value of 0.03 (post-test 1), 0.02 (Post-test 2) and 0.03 (post-test 3). In the entire three scores group B showed a significantly superior recovery than group A.

The within group analysis of group A using Friedman’s repeated measure analysis of variance on ranks showed that the difference in the mean values are greater than would be expected by chance \( \chi^2 \) value of 156.4 and a p value of 0.003. A Dunn’s analysis was done to draw multiple comparison which showed that there was no statistical difference between pre and post-test 1 (p=0.654), pre and post-test 2 (p=0.568) but there was statistical difference between and pre and post-test 3 (p=0.032).

The within group analysis of group B using Freidman’s repeated measure analysis of variance on ranks showed that the difference in the mean values are greater than would be expected by chance \( \chi^2 \) value of 160.2 and a p value of 0.002. A Dunn’s analysis was done to draw multiple comparison which showed that there was statistically significant difference between pre and post-test 1 (p=0.024), pre and post-test 2 (p=0.001) and pre and post-test 3 (p=0.012).

3.11.4. Analysis of WOMAC

In WOMAC index, baseline analysis showed no statistical difference between Group A and group B, With a mean and SD of 72.4 (4.73) and 75.2 (5.14) for group A and group B respectively. The between group analysis of post-test 1, post-test 2 and post-test 3 showed a statistically significant difference between each other with a p value of 0.04 (post-test 1), 0.03 (Post-test 2) and 0.02 (post-test 3). In all the three scores subjects in group B showed a significantly superior recovery than group A.

The within group analysis of group A using Friedman’s repeated measure analysis of variance on ranks showed that the difference in the mean values are greater than would be expected by chance \( \chi^2 \) value of 167.2 and a p value of 0.002. A Dunn’s analysis was done to draw multiple comparison which showed that there was no statistical difference between pre and post-test 1 (p=0.562), but there was statistical difference between pre and post-test 2 (p=0.03) and pre and post-test 3 (p=0.001).

The within group analysis of group B using Freidman’s repeated measure analysis of variance on ranks showed that the difference in the mean values are greater than would be
expected by chance $\chi^2$ value of 160.2 and a p value of 0.001. A Dunn’s analysis was done to draw multiple comparison which showed that there was statistically significant difference between pre and post-test 1(p=0.01), pre and post-test 2(p=0.02) and pre and post-test 3(p=0.021).
3.12. Discussion

Patellofemoral pain syndrome (PFPS) is a common problem in the sporting and general populations, particularly when repetitive lower limb stress is involved. (Dehaven, 1979) PFPS is defined as pain in anterior or retro-patellar region when there is absence of other pathology. Clinically the condition presents as vague pain, aggravated by activities such as climbing, kneeling and prolonged sitting and squatting. In spite of its huge prevalence, its etiology is still very minimally understood. The commonly known and proved hypothesis is imbalance of muscles and lateral tracking of the patella. (Wiseh, 1984)

So far all the treatment aims to restore the equilibrium of muscles and normalisation of patellar tracking system. Routine clinical practice addresses this aim by attempts to selectively activate vastus medialis oblique in functional positions, aided by therapeutic taping of the patella, improvement of pelvic muscle control, and reduction of tightness in lateral soft tissue structures, hamstrings, and the anterior hip muscles.

![Graph showing mean values of NPRS of group A and group B](image-url)
Fig 3.7. Mean values of McGill Pain Questionnaire of group A and group B
Fig 3.8. Mean values of AKPS of group A and group B
Fig 3.9. Mean values of WOMAC of group A and group B
The results of the present study are in support of the fact that biomechanical considerations do help physiotherapist in frames treatment for PFPS. The new tool adopted in group is a resultant of phase I analysis. In the analysis of NPRS it is proved that the groups were similar at the time of subject recruitment into the study. Though there was a significant improvement with group A intervention it did not happen as early as first week but in group B there was a faster improvement compared to group A thereafter had a sustained improvement. In the between group analysis it was very clear that the group B subjects improved better than group A subjects in every week.

In the analysis of McGill questionnaire it is proved that the groups were similar at the time of subject recruitment into the study. Though there was a significant improvement with group A intervention it did not take place as early as first week and second week but in group B there was a faster improvement compared to group A by third week thereafter had a sustained improvement. The improvement was seen only at the third week. In the between group analysis it was very clear that the group B subjects improved better than group A subjects at the end of second and third week.

In the analysis of anterior knee pain scale (Kujala scale) it is proved that the groups were similar at the time of subject recruitment into the study. Though there was a significant improvement with group A intervention it did not take place as early as second week but in group B there was a faster improvement compared to group A by third week thereafter had a sustained improvement. The improvement was seen only at the third week. In the between group analysis it was very clear that the group B subjects improved better than group A subjects in every week. The similar pattern of results are seen in the WOMAC scale too. Its obvious that the group A intervention though have shown significant improvement in function it had not happened as early as that happened in group B. From the analysis of all the four scales its illustrious that the group B intervention is more effective in terms of faster recovery, more complete recovery and sustained recovery.

Future studies can concentrate of finding long term follow up of the improvement gained. Studies can concentrate on bring about evidence-based protocol for PFPS management. The same approach can be adopted in other lower limb problems and thus evolve in more insightful treatment approaches.